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Grid Valuation of Beef Carcass Quality: Market Power and Market Trends

by

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Abstract

The fed cattle grid pricing system's premium and discount incentive mechanism is investigated. Two issues are addressed: a) we investigate changes in the weekly market value of an animal's carcass quality attributes as determined by the USDA-Agricultural Marketing Service (AMS) additive grid; and b) an evaluation of the effect of packer behavior on grid valuation of carcass quality attributes.

A pooled-cross sectional data set containing carcass information on 598 fed steers evaluated weekly on the AMS publically reported price grid (National Carcass Premiums and Discounts for Slaughter Steers and Heifers) was constructed for the years 2001 to 2008 (226,000 observations). Thus individual animal carcass quality characteristics are held constant through time.

For the 598 animals included in this study, the empirical evidence suggests that: a) premiums and discounts associated with specific carcass quality attributes have been adjusting over time; b) during periods of packer cooperative behavior in the fed cattle market, the market value of carcass quality declined, on average, by \$0.50 per hundred weight; and c) the average market value of an animal's carcass quality, meeting industry quality standards, exhibited a positive trend during the study period. This implies the grid incentive mechanism strengthened during this period for those producers who produced fed cattle that met industry quality standards.

Grid Valuation of Beef Carcass Quality: Market Power and Market Trends

Introduction:

Published studies in the grid pricing literature have focused on numerous issues revolving around the economic incentive structure associated with marketing on a grid (see Fausti et al. 2010 for a discussion of this literature). A subset of these studies has investigated how effective the grid premium and discount incentive mechanism has performed as an information transmission mechanism (e.g., Feuz 1999; Fausti and Qasmi 2002, Johnson and Ward 2005 and 2006; Fausti et al. 2014). To date, a long-run empirical study of grid premium and discount behavior has not been conducted for the post-MPR (Livestock Mandatory Price Reporting Act of 1999) era.

In addition, the empirical grid pricing literature has not addressed the issue of how market structure may influence the grid incentive mechanism. The issue of packer market power in the slaughter cattle market has been a popular area of study for economists. Empirical studies in this area have developed both long-run and short-run models to investigate packer market power in the meatpacking and fed cattle markets (e.g., Azzam and Anderson 1996; Ward 2010).

The issue of packer market power influencing fed cattle producer grid marketing decisions has been discussed in the theoretical (grid pricing) literature by Whitley (2002) and Fausti et al. (2013). No empirical investigation on whether oligopsony power influences grid premium and discount levels has appeared in the literature. Our objective is to investigate; a) long-run trends in the weekly market value of an animal's carcass quality attributes to assess the evolution of the grid pricing structure as a market signaling mechanism in the post-MPR era, and b) the effect of packer behavior on grid valuation of carcass quality attributes using identified periods of packer cooperative versus non-cooperative behavior (Cai et al. 2011). A linear mixed

modeling approach that encompasses both fixed and random effects is employed to identify factors that influence the market evaluation of carcass quality within a grid pricing mechanism.

Literature Review:

The two fields of literature associated with this study are: a) meat-packer behavior in the fed cattle market; and b) the evolution of the grid pricing mechanism for fed cattle. Both of these literature areas are extensive. To optimize space the discussion will focus on contributions germane to the issues addressed in this study. We direct the reader to Ward (2010) for a review of the issues and research on the beef industry's industrial structure. We suggest Fausti et al. (2010) for a discussion of the grid pricing literature.

Meat-Packer Conduct when Purchasing Fed Cattle

The meat-packing market-conduct empirical literature can be divided into long and short-run behavioral studies. Long-run behavioral studies on the fed cattle market have followed two approaches: a) structure-performance (e.g., Menkhaus et al. 1981); and b) conjectural variation (e.g., Schroeter 1988). Short-run empirical behavioral studies are based on game theory predictions of cooperative versus non-cooperative firm behavior within an oligopoly market structure (e.g., Koontz et al. 1993; Koontz and Garcia 1997; Carlberg et al. 2009; Cai et al. 2011). These studies evaluate changes in packer margins to identify cooperative and non-cooperative short-run behavior in the slaughter cattle market. The implication drawn from this literature is that oligopsony behavior in the slaughter cattle market is intermittent and the degree of market power varies across time.

The objective of Cai et al. (2011) is to evaluate the beef packing industry's fed cattle pricing behavior in the pre and post periods associated with implementation of the MPR. They

employ a Markov process within a regime switching regression model to identify periods of oligopsony behavior. Their empirical model provides time-period range estimates of collaborative versus non-collaborative packer pricing behavior (pp. 614-615). They conclude that during the post-MPR period, oligopsony rents were higher during cooperative periods, the duration of non-cooperative periods declined, and during non-cooperative periods firms behaved competitively. We rely upon the periods identified by Cai et al. (2011) to empirically test if packer oligopsony market power affected grid price assessment of carcass quality during cooperative periods.

Carcass Quality Attributes and Grid Price Transmission

The value based marketing initiative (National Cattlemen's Association: Value Based Marketing Taskforce 1990) was the beef industry's response to declining beef demand. The literature indicates that beef demand began to decline in the late 1970s, bottomed in the late 1990s and has not fully recovered (Schroeder et al. 1998; Fausti et al. 2010). The goal of this initiative is to increase beef demand by improving the overall quality of beef carcasses; and improve production efficiency along the beef supply chain. Grid pricing of fed cattle is a key component in the beef industry's value based marketing initiative. The beef industry identified the practice of selling fed cattle by the pen at an average price as a significant source of the inconsistency in carcass quality and a factor associated with weak beef demand (Fausti et al. 1998).

The grid pricing literature has documented that the outcome of selling cattle based on individual carcass merits is dependent of carcass quality. Therefore, the per-head grid revenue can be either above or below the pen average per-head price when cattle are sold live or dressed weight (e.g., Feuz et al. 1993; McDonald and Schroeder 2003). However, Ward (2005) shows that packers consistently pay more (less) for high quality cattle when purchased on a grid (live

weight by the pen) relative to mid-quality cattle purchased by dressed weight. Conversely, the literature also demonstrates that per-pen revenue variability increases when selling on a grid regardless of cattle quality (e.g., Fausti et al. 1998; Schroeder and Graff 2000; Anderson and Zeuli 2001; Feuz et al. 1995).

A number of studies have investigated the properties of the grid pricing method as a price transmission mechanism for market preferences with respect to specific carcass quality attributes (Feuz et al. 1993; Feuz 1999; Schroeder and Graff 2000; Fausti and Qasmi 2002; Johnson and Ward 2005 and 2006; Faust et al. 2014). The general consensus of the literature is that grid pricing mechanisms do transmit market preferences for carcass quality. However, the grid pricing system seems to have a bias toward discounts. This literature suggests that the incentive of grid premiums may not be strong enough to overcome the financial risk associated with grid discounts to induce a majority of fed cattle producers to sell their cattle on a grid (Fausti and Feuz 1995; Fausti et al. 1998; Fausti and Qasmi 2002; Johnson and Ward 2005 and 2006). Thus, it is argued that the discount bias represents a barrier to adoption by producers. In a recent study, Fausti et al. (2014) reports empirical evidence that this negative bias is weakening.

We extend this literature by empirically estimating the adjustment in grid premiums and discounts over time and quantifying their effect on the valuation of carcass quality attributes. To our knowledge, the long-run dynamic effect of grid premiums and discounts on individual carcass quality attribute valuation has not been addressed in the literature.

Theoretical Background

We are interested in the long-run economic relationship between carcass quality attributes and grid price signals. We investigate if: a) the grid price mechanism's premium and discount

structure is evolving over time; and b) identified periods of packer oligopsony behavior effect the grid pricing mechanism's valuation of carcass quality.

The innovative aspect of this research is the construction of a weekly pooled time-series cross-sectional data set that evaluates the grid incentive mechanism using the animal's assessed premium or discount relative to the grid's base price. Following the approach of Fausti and Qasmi (2002) and Fausti et al. (2014), the unique characteristic of this study is that carcass quality characteristics are held constant across time. Thus, market prices are the sole source of weekly variation in carcass value. This study differs from the above mentioned studies because our data set contains weekly AMS grid estimates for 598 individual steers rather than pen level averages.

Grid Pricing Mechanism

We adopt an approach followed by Feuz (1999). Feuz's study is unique because it focuses on the animal's levied premium or discount (pp. 333-34). Feuz's equation 5 encompasses an individual steer carcass's grid premium or discount per hundred weight. Simplifying Feuz's equation 5, we arrive at Feuz's "value based price premium" (VBP). We derive our version of VBP following the approach discussed in Fausti et al. (1998). Fausti et al. suggest using the AMS additive grid to derive VBP estimates for individual animal dressed weight carcasses.

Our extension of the Feuz approach allows us to evaluate a single set of slaughter steers over an extended time period. We hypothesize that the influence of the interaction of an animal's carcass quality attributes and a grid's incentive mechanism on VBP can be revealed by identifying the dynamics of the market on carcass valuation over time.

Market Power in the Fed Cattle Market

The second hypothesis to be empirically tested in this study is if there is evidence of oligopsony market power in the grid pricing system. Cai et al. (2011) empirically identify periods of cooperative and non-cooperative market power in the fed cattle market that has resulted in oligopsony rents in the post-MPR period. Their empirical model is derived from the theoretical underpinnings of a branch of the Industrial Organization literature, commonly referred to as the “new empirical industrial organization” branch (Calberg et al. 2009). Cai et al. (2011: pp. 608-11) presents theoretical and empirical models based on firm behavioral assumptions outlined in Mailath and Samuelson (2006) for a multiple player dynamic game. Cai et al. (2011) use a Markov regime switching model to estimate packer margins that provide approximations for dating and duration of cooperative and non-cooperative regimes in the fed cattle market (page 615).

To test if market power is affecting a slaughter steer’s VBP; we model the periods identified by Cai et al. (2011: Table 3/Figure 2) as cooperative and non-cooperative behavior using a simple bivariate dummy variable. It is assumed that the market power price effect varies randomly across the 598 steers. The random effects assumption is consistent with the literature’s conclusion that oligopsony behavior in the slaughter cattle market is intermittent and the degree of market power varies across time.

Data:

A pooled time series; cross-sectional data set containing carcass information on fed steers evaluated weekly on the USDA-AMS publically reported price grid (National Carcass Premiums and Discounts for Slaughter Steers and Heifers) was constructed for the years 2001 to 2008. The

carcass data contain carcass characteristics for 598 slaughter steers (see Table 1) collected by the Animal Science Department at SDSU as part of a ranch to rail study (Fausti et al. 2003).

The price data were collected from USDA weekly grid premium and discount reports. We used an additive premium and discount price grid as suggested by Fausti et al. (1998). The price data were used to simulate individual animal weekly per head VBP using the AMS price grid data from April 2001 to June 2008. We also collected AMS weekly reported Nebraska dressed weight price (35% to 65% choice) to represent the general price level for the slaughter cattle market (*Nebraska Weekly Direct Slaughter Cattle-Negotiated Purchases (LM_CT158)*). Price data is combined with individual animal carcass characteristics. A total of 378 weeks of price data were simulated. The data set contains 226,044 observations.

The dating of meatpacker cooperative versus non-cooperative behavior periods is based on estimates of cooperative behavior duration by Cai et al. (2011: page 615-Table 3). Based on Cai et. al. (2011) we determined that there were eight cooperative periods that occurred between 2004 and 2008. These periods are listed in Table 2. In Table 3, the simple bivariate dummy representing cooperative periods (MP) has a mean of 0.548, indicating that during the period of our study cooperative regime behavior occurred approximately fifty-five percent of the time.

Empirical Methodology:

Approach

A pooled time-series regression model is used to investigate the influence of carcass quality characteristics on an individual animal's premium or discount per hundredweight relative to the AMS grid base price. We refer to this levied premium or discount as VBP. We regress VBP on dummy variables reflecting individual steer carcass quality based on categories defined by the

AMS grid. We employ quarterly dummy variables to account for seasonality, a time trend variable, interaction terms, and the weekly hot carcass dressed weight price. We also employ a simple bivariate dummy variable (MP) reflecting periods of packer cooperative versus non-cooperative behavior.

The standard assumptions associated with the linear mixed model (LMM) are listed in equations 1-4. Using the standard vector notation provided in the SAS/Stat 9.3 User Guide (SAS Institute, 2011), we define the general structure of the model as:

1. $VBP = X\beta + Z\gamma + \varepsilon$,
2. $\gamma \sim N(0, G)$,
3. $\varepsilon \sim N(0, R)$, and
4. $COV(\gamma, \varepsilon) = 0$.

The dependent variable (VBP) denotes the vector of dependent variable observations. Matrix X is the design matrix associated with β , which represents the vector of unknown fixed effects parameters. Matrix Z is the design matrix associated with γ , representing the vector of unknown random effects parameters. The error term, ε , reflects an unknown random error vector. Equation 4 states that γ and ε are independent, which implies that the variance of VBP (SAS Institute, 1999: p. 2087) can be defined as:

$$5. \text{VAR}[VBP] = ZGZ^T + R.^1$$

Matrices G and R are the covariance matrices associated with γ and ε , respectively. The mixed procedure requires the covariance matrices G and R to be specified. We used a variance components specification for G and a blocked (subject-dependent) first order autoregressive specification for R . These specifications are based on regression diagnostics.

¹ The superscript notation “T” denotes the transpose matrix operation.

A Mixed Effects model that includes both fixed and random effects was selected to analyze the data. Equation 1 provides the general functional form for a Mixed Effects model and below is our modified version:

$$6) VBP_{it} = \alpha + \sum_{j=1}^8 \beta_j C_{ijt} + \sum_{i=1}^{598} \gamma_i Z_{it} + \delta T_t + \sum_{k=1}^3 \theta_k S_{ikt} + \sum_{j=1}^8 \varphi_j C_{ijt} T_t + \omega P_t + \rho P_t T_t + \vartheta MP_t + \varepsilon_{it}, \text{ where } i = 1 \text{ to } 598, j = 1 \text{ to } 8, k = 1 \text{ to } 3, \text{ and } t = 1 \text{ to } 378.$$

For our analysis: a) VBP_{it} denotes the individual animal's weekly grid determined carcass quality attribute valuation (defined in terms of dollars per hundred weight; b) C denotes individual animal carcass quality characteristics; c) T denotes the time trend variable; d) S denotes the seasonal quarterly dummy variables; e) P denotes the AMS reported Nebraska dressed weight price (HCWP); f) MP denotes a fixed effects bivariate dummy variable representing cooperative and non-cooperative periods; and g) Z is the design matrix associated with γ_i , the random effects parameter estimate, and ε is as defined above. Subscripts denote matrix dimensions: a) subscript i denotes the number of subjects; b) subscript j denotes the number of carcass quality dummy variables; c) subscript t denotes the number of time periods; and d) subscript k denotes the number of seasonal dummy variables. Parameters α , β , θ , δ , φ , ω , ρ , and ϑ represent fixed effects, and γ denotes the random effects parameter estimate.

Fixed and Random Effects Variables Defined

Quarterly seasonal dummy variables were constructed with October, November, and December designated as the base quarter, along with a weekly time trend variable. Based on the Cai et al. (2011) we constructed a bivariate dummy variable representing packer cooperative (MP=1) versus non-cooperative periods (MP=0). The MP variable was also selected as the random effects variable to test the Cai et al. (2011: p.625) conclusion that "...estimates of regime-dependent variances, p_1 and p_2 , are significant and vary across regimes." Thus, the MP fixed

effects estimate is the average effect across all subjects (steers) and the random effects assumption produces unique estimates for individual steers.

We included P_t to determine if a change in the market price for slaughter cattle affected how the market rewards carcass characteristics over time. Fausti and Qasmi (2002) hypothesized that such a relationship may exist between the HCWP and grid premium and discount levels.

Carcass quality variable categories are based on marbling score and kidney/pelvic/heart fat measurements and were then converted into dummy variables. Quality grade categories are prime, choice, select, and standard, with choice as the base. Yield grade variable categories are yield grade less than 2 (YG1), yield grade between 2 and 3 (YG2), and yield grade of 4 or greater (YG45). The yield grade category 3 to 4 is designated as the base. Heavy weight carcass dummy variable (HWT) reflects a carcass with $HCW > 950$ and the light weight carcass dummy variable (LWT) reflects a carcass with $HCW < 600$. Interaction terms combining the time trend variable with carcass traits are used to determine if there is a trend in the market incentive mechanism. HCWP interaction term was included to test if the market price level influence on grid premium and discount levels has been changing over time. Summary statistics for exogenous variables are provided in Table 3.

Model Diagnostics

The empirical analysis was conducted using SAS version 9.3. The Mixed Effects model was estimated using SAS's *Restricted Maximum Likelihood* method. The LMM procedure in SAS provides great flexibility dealing with regression diagnostic issues (SAS Institute, 1999). First, we conducted stationary tests for the two continuous variables in our model, VBP and HCWP. The Phillips-Perron Unit Root Test (SAS-ETS 1999: p.332) indicated that both variables are stationary at a p-value of less than 0.001.

Next, we employed a “sandwich estimator” approach to produce robust standard errors associated with parameter estimates (SAS Institute, 1999, chapter 41; and Diggle et al., 1994). The default covariance structure for the Mixed procedure is variance components (SAS 1999: p. 2088).¹ Other covariance structures for *G* and *R* were investigated. The variance components structure was selected for matrix *G*, and the autoregressive of order one was selected for matrix *R*. Both covariance structure assumptions were based on the “Null Model Likelihood Ratio Test.” We also used the Likelihood Ratio Test to determine if the random effects assumption was valid. The test indicated that this assumption is valid at a p-value less than 0.001.

Results:

Summary statistics presented in Table 3 indicate 52.21% of the 598 carcasses graded choice, 39.6% graded select, 6.85% graded standard, and 1.34% graded prime. Carcasses receiving a yield grade less than 2 accounted for 17.2% of the sample. Yield grade 2 to 3 accounted for 48.3%, and 6% received a yield grade of 4 or greater. Yield grade 3 to 4 carcasses accounted for 28.5% of the sample. Carcasses determined to either HWT and LWT accounted for 1% and 2% of the carcasses graded, respectively. The per-hundred weight premium/discount variable (VBP) averaged -\$4.87.

The variance components estimating procedure provided evidence that the variance associated with matrix *G*’s contribution to the variance of matrix *V* (covariance matrix for VBP) was significant at the one percent level (Table 4). Given the statistical significance of the random effects covariance parameter estimate and the Likelihood Ratio Test result, we believe the mixed model assumption is justified.

¹ The Likelihood Ratio Test indicated that variance components covariance matrix was superior to the OLS diagonal covariance structure ($\sigma^2 I$), where *I* is the identity matrix.

Overview of Fixed Effects Estimates

Type 3 tests indicate that all fixed effects variables are statistically significant at a p-value less than 0.01. The fixed effects intercept estimate is -\$0.84 (Table 5). This intercept represents the industry standard carcass. The industry standard carcass is the default carcass quality in our empirical model. If all of the fixed effect dummy variables are set to their default value, and assume $t=0$ and $HCWP = \$100$, then a quality grade choice, yield grade 3 carcass weighing between 600 and 950 will receive: $VBP = -\$0.84 + \$0.63 = -\$0.21$ per hundred weight. At the other end of the time spectrum ($t=378$), when $HCWP$ is \$100 cwt, the VBP for the industry standard carcass is estimated at: $-\$0.84 + \$0.63 + \$1.46 = \1.25 per hundred weight. These back of the envelope calculations suggest that the long-run trend reflected in the grid price signaling mechanism is positive for steer carcasses that meet the industry standard. This finding is consistent with Fausti et al. (2014).

Fit statistics for the LML model are provided in Table 4. We conclude the fixed effects component of the model does explain differences in VBP across individual animals included in the data set. Fixed effects parameter estimates for main and interaction effect variables are presented in Table 5.

Main Effects

All carcass quality dummy parameter estimates have the expected sign (premium versus discount). The parameter values fall within the expected range, given the inclusion of the interaction terms.

Quarterly seasonal dummy variable parameter estimates indicate that relative to the fourth quarter; VBP increases in the first and third quarters, and declines in the second quarter. The seasonality estimates are consistent with the literature (e.g., Fausti and Qasmi 2002).

The parameter estimate for HCWP is positive and significant ($p < 0.001$) indicating that while the market price for slaughter cattle is not directly related to VBP it does positively influence VBP. This finding supports the *Supply Response Hypothesis* proposed by Fausti and Qasmi (2002: p. 31).

The *market power* dummy variable (MP) was negative and significant ($p < 0.001$) indicating that during cooperative periods VBP declined by approximately \$0.50 per hundredweight relative to non-cooperative periods. For a dressed carcass weighing 800 pounds, this implies a reduction of four dollars in per head revenue. Our empirical results support empirical work of Cai et al. (2001) demonstrating that the packing industry generates oligopsony rents in the fed cattle market during cooperative periods. Our contribution to the market structure literature is that there is also evidence of oligopsony rents being extracted when slaughter cattle are sold on a grid during cooperative periods.

Indirect Fixed Effects

We created interaction terms between T_t and C_{ijt} , and between T_t and $HCWP_t$. The interaction terms indicate that the quality characteristics of Prime and YG1 exhibit a positive trend in market value with respect to their influence on VBP over time. The quality characteristics of Standard, YG45, and LWT all exhibit a negative trend, suggesting that these carcass attributes experienced a deepening of the market discount during the period of the study. The carcass attributes of YG2 and HWT both had unexpected signs. The interaction term for yield grade 2-3 was negative; indicating the premium paid for this attribute has weakened. The interaction term for HWT was positive suggesting this discount category has weakened. The parameter estimate for Select carcass interaction term was negative. This suggests that the discount on select quality grade carcasses deepened during this period.

Overall, the interaction terms indicate a pattern of intensification across grid discounts and premiums. This suggests a strengthening of market signals for specific characteristics. This is especially true with respect to the quality grade versus yield categories. The interaction parameter estimates for quality grade categories are an order of magnitude higher than for the yield grade categories.

The final interaction term estimated was for HCWP. The parameter estimate was negative and statistically significant, but the low magnitude suggests the relationship between VBP and market price had a significant positive relationship overall. This suggests that the rising price of cattle played an important role in the positive change in VBP over the seven year period.

Overview of Random Effects Estimates

We hypothesize that oligopsony market power represents a random effects explanatory variable based on the work of Cai et al. (2011). Using the variance components estimating procedure we found that the MP covariance parameter estimate associated with matrix G was statistically significant at less than one percent. This supports the supposition that there is variability in the level of persistence and intensity of oligopsony market power in the fed cattle grid pricing system (Table 4).

The random effects option in SAS also produces parameter estimates for γ_i . The fixed effects parameter estimate for MP (-\$0.50) represents the average effect of oligopsony behavior for the group of 598 head during cooperative periods.¹ The parameter estimates for γ_i represent the estimated effect of cooperative periods on individual steers. Thus these estimates (not reported but summary statistics for γ_i are reported in Table 1) reflect the marginal adjustment to

¹ The fixed effects parameter estimate for MP represents a shift in the estimated intercept. The -\$0.50 per hundredweight is an estimate of oligopsony rent during cooperative periods relative to non-cooperative periods. Cai et al. (2011: p. 614) concluded that during non-cooperative periods in the post MPR period packers behaved competitively.

fixed effect parameter estimate for MP due to differences in carcass quality attributes across the 598 steers.

To gain insight on how cooperative periods affect the grid premium and discount structure we ran an auxiliary OLS regression. We regressed the γ_i parameter estimates on the carcass quality attribute dummy variables; C_{ij} . We employed a simple OLS model that is defined in equation 7 (SAS Ver. 9.3):

$$7) \gamma_i = \alpha + \sum_{j=1}^8 \beta_j C_{ij} + \varepsilon_i, \quad \text{where } i = 1 \text{ to } 598.$$

We tested for multicollinearity and heteroscedasticity. Variance Inflation Factor (VIF) estimates are all less than 2. However, heteroscedasticity was detected and a White correction procedure was implemented to generate Heteroscedasticity Consistent-Standard Errors (White 1980, p. 822). We also generate and report partial R-square estimates (Table 6).

All of the explanatory variables were statistically significant and negative, except prime and YG1 were positive (Table 6). The estimated intercept (\$0.41) represents the adjustment to the fixed effect (MP) parameter estimate for an industry standard carcass (Choice, YG3, 600-950 lbs.). This estimate suggests that packers did extract \$0.09 per hundredweight in oligopsony rent during cooperative periods from carcasses meeting the industry quality standard. The positive coefficient for prime (\$0.05) suggests that even prime carcasses were subject to a small oligopsony rent (\$0.04) during the period covered in this study. This is surprising given that only a very small percentage of carcasses grade prime and this carcass attribute is primarily purchased by white tablecloth restaurants; a very competitive niche market.

Parameter estimates for yield grade characteristics are statistically significant. Only the YG1 had a positive parameter estimate. This suggests that both yield grade premiums and

discounts experienced downward pressure during cooperative periods. Both the LWT and HWT discounts were also negatively affected during cooperative periods.

Parameter estimates for select and standard carcasses indicate that quality grade discounts experienced the greatest pricing pressure during cooperative periods. During cooperative periods the select and standard grade category discounts deepened by \$0.87 and \$0.88 per hundredweight, respectively. In addition the partial R-square estimates indicate that select and standard grade categories explained eighty and nineteen percent of the variability in γ_i , respectively (table 6). This finding is consistent with literature on importance of the choice/select spread in a grid pricing system (e.g. Ward and Johnson 2005). The remaining variables, combined, contribute less than one percent to the model's R-square.

The empirical evidence suggests that during cooperative periods, packing firms extracted oligopsony rent primarily through the grid discount structure. Within the grid discount structure, oligopsony rent was extracted primarily from the carcass quality grade discount categories. The empirical evidence further suggests that oligopsony pricing power focused primarily on the grid discount structure lends credence to a general complaint raised by producers that the grid system is a pricing system of discounts only (e.g., Fausti et al. 1998; Johnson and Ward 2005).

Discussion:

A long-run empirical analysis investigated the grid pricing system's ability to convey market signals, and if meatpackers exerted oligopsony pricing in the slaughter cattle market for cattle sold on a grid. With respect to the transmission of market signals, we adopted an approach suggested by Feuz (1999). Empirical evidence suggests that, on average, a pattern of intensification across grid discounts and premiums has occurred over time. This trend has led to

a general improvement in the market valuation of carcass quality attributes for the 598 steers included in this study that meet the industry standard for carcass quality. This positive trend suggests the barriers to grid price adoption are weakening over time, but the grid discount structure continues to be an issue.

The second objective focused on oligopsony market power in the slaughter cattle market. The work of Cai et al. (2011) was extended by adopting their empirical duration estimates of cooperative meatpacker behavior. We incorporated identified periods of cooperative behavior into the empirical model to test if oligopsony market power affected an individual steer's carcass premium and discount. The empirical results indicate that indeed, during periods of cooperative behavior, packers extracted oligopsony rents primarily through the deepening of carcass quality discounts. Thus, one could argue that oligopsony behavior during cooperative periods could pose a barrier to adoption for those producers who are uncertain about the quality of the cattle they are marketing.

References:

- Anderson, J. D., & Zeuli, K. A. (2001). The revenue risk of value-based pricing for fed cattle: a simulation of grid vs. average pricing. *The International Food and Agribusiness Management Review*, 4(3), 275-286.
- Azzam, A. M., & Anderson, D. G. (1996). *Assessing competition in meatpacking: Economic history, theory, and evidence*. US Department of Agriculture, Packers and Stockyards Programs, Grain Inspection, Packers and Stockyards Administration.

- Cai, X., Stiegert, K. W., & Koontz, S. R. (2011). Oligopsony Fed Cattle Pricing: Did Mandatory Price Reporting Increase Meatpacker Market Power?. *Applied Economic Perspectives and Policy*, 33(4), 606-622.
- Carlberg, J. G., Hogan, R. J., & Ward, C. E. (2009). Game theory application to fed cattle procurement in an experimental market. *Agribusiness*, 25(1), 56-69.
- Diggle, P. J., Liang, K. Y. & Zeger S.L. (1994). *Analysis of Longitudinal Data*. Oxford University Press.
- Fausti, S.W., and D.M. Feuz. (1995). Production Uncertainty and Factor Price Disparity in the Slaughter Cattle Market: Theory and Evidence. *American Journal of Agricultural Economics* 77(3):533-543.
- Fausti, S. W., D. M. Feuz, & J. J. Wagner. (1998). Value-based marketing for fed cattle: A discussion of the issues. *International Food and Agribusiness Management Review* 1(1), 73–90.
- Fausti, S. W., & B. A. Qasmi. (2002). Does the producer have an incentive to sell fed cattle on a grid? *International Food and Agribusiness Management Review* 5(1), 23–39.
- Fausti, S. W., Johnson, B., Epperson, W., & Grathwohl, N. (2003). *Risk and the Economic Incentive to Retain Ownership of Steer Calves*. Economics Department, South Dakota State University. <http://purl.umn.edu/32023> Accessed January 2014.
- Fausti, S.W., B.A. Qasmi, M.A. Diersen & J. Li. (2010). Value based marketing: A discussion of issues and trends in the slaughter cattle market. *Journal of Agribusiness* 28 (2): 89-110.
- Fausti, S. W., Wang, Z., & Lange, B. (2013). Expected Utility, Risk, and Marketing Behavior: Theory and Evidence from the Fed Cattle Market. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 61(3), 371-395.

- Fausti, S. W., Wang, Z., Qasmi, B. A., & Diersen, M. A. (2014). Risk and marketing behavior: pricing fed cattle on a grid. Published online in *Agricultural Economics*.
- Feuz, D. M., Fausti, S. W., & Wagner, J. J. (1993). Analysis of the efficiency of four marketing methods for slaughter cattle. *Agribusiness*, 9(5), 453-463.
- Feuz, D. M., Fausti, S. W., & Wagner, J. J. (1995). Risk and Market Participant Behavior in the US Slaughter-Cattle Market. *Journal of Agricultural & Resource Economics*, 20(1), 22-31.
- Feuz, D. M. (1999). Market Signals in Value-Based Pricing Premiums and Discounts. *Journal of Agricultural and Resource Economics* 24, 327-341.
- Johnson, H. C., & C. E. Ward. (2005, December). Market signals transmitted by grid pricing. *Journal of Agricultural and Resource Economics* 30(3), 561–579.
- Johnson, H. C., & C. E. Ward. (2006). Impact of beef quality on market signals transmitted by grid pricing. *Journal of Agricultural and Applied Economics* 31(1), 77–90.
- Koontz, S. R., Garcia, P., & Hudson, M. A. (1993). Meatpacker conduct in fed cattle pricing: An investigation of oligopsony power. *American Journal of Agricultural Economics*, 75(3), 537-548.
- Koontz, S. R., & Garcia, P. (1997). Meat-Packer Conduct in Fed Cattle Pricing: Multiple-Market Oligopsony Power. *Journal of Agricultural & Resource Economics*, 22(1).
- McDonald, R. A., & Schroeder, T. C. (2003). Fed cattle profit determinants under grid pricing. *Journal of Agricultural and Applied Economics*, 35(01).
- Mailath, G. J., & Samuelson, L. (2006). Repeated games and reputations: long-run relationships. *Oxford University Press*.
- Menkhaus, D. J., Clair, J. S. S., & Ahmaddaud, A. Z. (1981). The effects of industry structure on price: A case in the beef industry. *Western Journal of Agricultural Economics*, 6(2), 147-53.

- National Cattlemen's Association. (1990). "The War on Fat!." Final report of the Value-Based Marketing TaskForce, NCA, Englewood CO.
- SAS Institute. (1999). *SAS/ETS® User's Guide: Version 8*, SAS Institute Inc., Cary, NC; SAS Institute Inc.
- SAS Institute. (1999). *SAS/STAT® User's Guide: Chapter 41, Version 8*. Cary, NC: SAS Institute Inc.
- SAS Institute. (2011). *SAS/STAT® User's Guide: Chapter 6, Version 9.3*. Cary, NC: SAS Institute Inc.:
- http://support.sas.com/documentation/cdl/en/statug/63962/HTML/default/viewer.htm#statug_mixed_sect003.htm Accessed October 2013.
- Schroeder, T. C., Ward, C. E., Mintert, J. R., & Peel, D. S. (1998). Value-based pricing of fed cattle: challenges and research agenda. *Review of Agricultural Economics*, 20(1), 125-134.
- Schroeder, T. C., & Graff, J. L. (2000). Estimated value of increased pricing accuracy for fed cattle. *Review of Agricultural Economics*, 22(1), 89-101.
- Schroeter, J. R. (1988). Estimating the degree of market power in the beef packing industry. *Review of Economics and Statistics*, 70(1), 158-162.
- U.S.Department of Agriculture, Agricultural Marketing Service. (April, 2001-2008). *National Carcass Premiums and Discounts for Slaughter Steers and Heifers (LM_CT155)*, weekly reports.
- U.S. Department of Agriculture, Agricultural Marketing Service. (April 2001-2008). *Nebraska Weekly Direct Slaughter Cattle-Negotiated Purchases (LM_CT158)*, weekly reports

- Ward, C. (2010). Economics of Competition in the U.S. Livestock Industry. Economics Oklahoma State University: <http://www.justice.gov/atr/public/workshops/ag2010/016/AGW-15639-a.pdf>. Accessed January 2014.
- Ward, C. E. (2005). Price Discovery and Pricing Choice Under Divergent Supply Scenarios in an Experimental Market for Fed Cattle. *Journal of Agricultural & Resource Economics*, 30(3).
- White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica: Journal of the Econometric Society*, 817-838.
- Whitley, J. E. (2002). The political economy of quality measurement: a case study of the USA slaughter cattle market. *Australian Journal of Agricultural and Resource Economics*, 46(4), 515-538.

Table 1. Cattle Quality Characteristics and γ_i Estimates: 598 OBS

Variable ¹	N	Mean	Std Dev	Minimum	Maximum
HCW	598	743.186	74.246	579.000	991.000
Dress	598	60.683	2.081	53.086	69.700
REA	598	12.548	1.437	8.100	20.300
FT	598	0.433	0.175	0.100	1.100
KPH	598	1.866	0.598	0.500	3.500
Marb	598	493.094	91.653	340.000	830.000
YG	598	2.746	0.751	0.564	5.237
QG	598	2.520	0.644	1.000	4.000
γ_i	598	0.003	0.475	-0.814	0.5499

1. Variable acronyms: a) HCW is hot carcass weight; b) Dress is animal dressing percentage; c) REA is rib-eye area; d) FT denotes fat thickness over the 7th rib; e) KPH is kidney-pelvic-heart fat measurement; f) MARB is marbling score; g) YG denotes USDA yield grade score; h) QG is USDA yield grade score; and i) denotes the OLS parameter estimate for the effect of MP on individual steer VBP.

Table 2. Beef Packing Industry Cooperative Time Periods

Cooperative Period	Period (weeks)	Start Date	End Date
MP1	0<weeks<39	04/09/01	12/26/01
MP2	53<weeks<81	04/15/02	10/14/02
MP3	106<weeks<150	04/21/03	02/09/04
MP4	157<weeks<168	04/12/04	06/21/04
MP5	206<weeks<220	03/21/05	06/13/05
MP6	241<weeks<283	11/21/05	08/28/06
MP7	299<weeks<324	01/01/07	06/18/07
MP8	367<weeks	04/12/08	06/21/08

Table 3. Summary Statistics: VBP Data Set

Variable	N	Mean	Std Dev	Minimum	Maximum
VBP (dependent)	226044	-4.868	6.780	-44.430	15.280
QS1	226044	0.238	0.426	0.000	1.000
QS2	226044	0.272	0.445	0.000	1.000
QS3	226044	0.243	0.429	0.000	1.000
Time	226044	189.500	109.119	1.000	378.000
Prime	226044	0.013	0.115	0.000	1.000
Choice	226044	0.522	0.500	0.000	1.000
Select	226044	0.396	0.489	0.000	1.000
Standard	226044	0.069	0.253	0.000	1.000
YG1	226044	0.172	0.378	0.000	1.000
YG2	226044	0.483	0.500	0.000	1.000
YG45	226044	0.060	0.238	0.000	1.000
HWT	226044	0.010	0.100	0.000	1.000
LWT	226044	0.022	0.146	0.000	1.000
HCWP	226044	131.314	15.887	97.800	172.460
MP	226044	0.548	0.497	0.000	1.000

Table 4. Variance Components Statistics and LML Model Fit Statistics

Covariance Parameter	Covariance Parameter Estimate & Z statistic
MP	0.2157: Z=14.28
AR(1)	0.9626: Z=1688.4
Residual	8.3747: Z=65.72
<u>LML Fit Statistics</u>	
-2 Log Likelihood	534260.7
AIC	534266.7
BIC	534279.9
Intraclass Correlation Coefficient	ICC _{MP} = 2.26% ICC _{AR1} = 10.08%
Likelihood Ratio Test: Unrestricted Model (Mixed Effects MP) Versus Restricted Model (Fixed Effects MP)	Likelihood Ratio Test Statistic=1784.8 Pr> ChiSq <.0001 with DF=1.

Table 5. VBP REML Fixed Effects Parameter Estimates

Variable	DF	Estimate	Std. Error	t Value	Pr > t
Intercept	23K	-0.8389	0.0663	-12.66	< .0001
QS1	23K	0.1526	0.0082	18.55	< .0001
QS2	23K	-0.2092	0.0099	-21.03	< .0001
QS3	23K	0.1999	0.0088	22.80	< .0001
Time	23K	0.0039	0.0004	9.27	< .0001
Prime	23K	4.7287	0.0540	87.51	< .0001
Select	23K	-7.9377	0.0256	-310.52	< .0001
Standard	23K	-16.7322	0.2711	-61.72	< .0001
Yg1	23K	2.7584	0.0467	60.39	< .0001
Yg2	23K	1.5183	0.0189	80.14	< .0001
Yg45	23K	-13.3550	0.2246	-59.47	< .0001
HWT	23K	-9.1095	0.0640	-142.37	< .0001
LWT	23K	-3.5585	0.9774	-3.64	0.0003
HCWP	23K	0.0063	0.0006	11.18	< .0001
Time*Prime	23K	0.0167	0.0001	259.74	< .0001
Time*Select	23K	-0.0036	0.0001	-85.52	< .0001
Time*standard	23K	-0.0029	0.0001	-31.81	< .0001
Time*Yg1	23K	0.0004	0.0001	5.85	< .0001
Time*Yg2	23K	-0.0006	0.0001	-13.72	< .0001
Time*Yg45	23K	-0.0010	0.0001	-16.96	< .0001
Time*HWT	23K	0.0132	0.0001	173.06	< .0001
Time*LWT	23K	-0.0008	0.0003	-3.08	0.0021
Time*HCWP	23K	-0.00003	0.0001	-9.90	< .0001
MP	597	-0.4966	0.0209	-23.78	< .0001

Table 6. OLS Estimates of MP Random Effects Coefficient Model

Variable	DF	Estimate	Std Error	t Value	Pr > t	Partial R ²
Intercept	1	0.4071	0.0016	249.28	< .0001	
Prime	1	0.0465	0.0073	6.35	< .0001	0.0002
Select	1	-0.8729	0.0020	-448.73	< .0001	0.7992
Standard	1	-0.7781	0.0036	-215.73	< .0001	0.1925
Yg1	1	0.0413	0.0029	14.51	< .0001	0.0019
Yg2	1	-0.0167	0.0021	-8.03	< .0001	0.0003
Yg45	1	-0.1019	0.0038	-27.08	< .0001	0.0030
LWT	1	-0.0105	0.0058	-1.81	0.0715	0.0000
HWT	1	-0.1033	0.0084	-12.27	< .0001	0.0006

Model: DF=8, Sum of Sqs=106.5184, Mean Sq=13.3148, F value=31836.8, Pr> F <.0001

Error: DF=589, Sum of Sqs=0.2463, Mean Sq=0.0004

Root MSE=0.02005, R²=0.9977